PLANTING SITES IN THE NORTHEAST

A tentative classification prepared by the Committee on Site Classification of the Northeastern Forest Soils Conference

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PREFACE

TREE planting involves many considerations — site classification, selection of species, planting practices, and protection from fire, insects, and diseases. The information about many of these aspects of planting is scattered and fragmentary.

To bring this information together in forms that will be useful to the forester and landowner, two professional groups have been working for some time. A committee of the Northeastern Forest Soils Conference has gathered information to prepare a tentative planting-site classification for the Northeast and the Silviculture Committee of the Allegheny Section of the Society of American Foresters has made a survey of current tree-planting practices in its territory.

The Northeastern Forest Experiment Station of the U. S. Forest Service is publishing the reports of both committees. This is the first of the two reports. The other report, titled "Tree planting in the Allegheny Section," will follow soon as No. 158 in the Station's series of Station Papers.

This report on planting sites represents the work of an extremely elastic and informally organized committee under the chairmanship of Earl L. Stone of Cornell University. Some 30 people participated in the committee's work at one time or another, and various other individuals have been consulted or have helped in less direct ways.

The general scope and style of the report was worked out largely by the chairman, who also wrote the introductory sections. The various area descriptions and guides were prepared by local, loosely defined subcommittees of one to several men each.

Since it would be almost impossible now to designate with full justice the members that contributed most substantially to the committee's work and to this report, all except the chairman shall remain anonymous. Earl Stone served as chairman for the full life of the committee, kept it alive and functioning, and sparked it with ideas, inspiration, and his own participation in developing guides for New York State. To him belongs the major credit for pressing the committee's work to completion and the assembling of this report.

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by

Committee on Site Classification
Northeastern Forest Soils Conference

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INTRODUCTION

TWENTY centuries ago Virgil observed that, "Not every land can nourish every tree." Yet progress towards more specific recommendations has been slow. Forest planting has been a popular activity supported with public funds for more than 50 years in the Northeast, but there has been little critical evaluation of the site conditions that govern success or failure. Planting recommendations are often phrased in general terms. Soils in which trees are to grow for some decades are still characterized according to a single factor; they are typed as dry or moist, sandy, loamy, or heavy, whereas actual soils affect tree growth by more complex combinations.

Nevertheless, forest planting in the Northeast represents a large annual investment. Although current rates of planting are somewhat higher than normal because of the Soil Bank Program, they illustrate the point. In 1960 some 110,000 acres, exclusive of Christmas-tree plantations, were planted in the twelve Northeastern States.[1] Costs for nursery production and planting under easy conditions commonly range around $40 per acre, and on the more difficult sites will run considerably higher. Moreover, almost 5 million acres of commercial forest land still is available for planting in these states.[2]

In 1951 Arthur Bevan, then Chief of the Division of Forest Influences Research of the Northeastern Forest Experiment Station, foresaw that expanded private and public planting in the future would call for better planting-site classification. At his suggestion the Northeastern Forest Soils Conference established a committee charged with preparing such a classification.

The requirements of this planting-site classification were that it be widely applicable, that it be usable by foresters unskilled in soil science and yet be technically adequate, at least so far as present knowledge of the relationships between plantation success and soil properties allows. Though experience with planting sites and species is indeed considerable, much of it is only locally applicable, some is contradictory, and little is rigorous. From the beginning, the committee accepted the limitations of its sources and the tentative character of its recommendations, reflecting that at the present pace another half century might elapse before a classification could be based on truly adequate information.

First, attention was given to methods of characterizing and identifying the more common planting situations, and then to rating the performance of useful species on each. For both steps, the committee had to rely on observations and digests of local experience by members and their associates. In this way the limited research on site selection and the invaluable contribution of soil survey workers was brought together. Without the help of associates in soil survey and elsewhere, preparation of the classification would have been practically impossible.

The earlier drafts of the committee's work evoked much interest, and some material from them has been incorporated in recommendations of individual states and Soil Conservation Districts. Accordingly, the committee believes that though the present guides are only tentative, they will be most useful if given wider distribution.

[1] U.S. Forest Service. Annual planting report—1960. Tree Planters Notes No. 44. 1960.

[2] U.S. Forest Service. Timber resources for America's future. U.S. Dept. Agr. Forest Resources Rpt. 14. 1958.

THE GUIDES AND HOW TO USE THEM

The planting guides serve two purposes: (1) to identify and characterize the kinds of soil situations commonly met with in forest planting, and (2) to indicate what success can be expected in different situations from various tree species. The guides are designed to facilitate the selection of suitable tree species for particular locations, since this is the usual problem facing the forest planter, rather than finding a soil to fit a species.

The guides apply to lands likely to be planted, not land that already is in forest or land that will probably remain in agriculture. Ordinarily the plantable lands are abandoned fields and pastures, less desirable farm lands or, occasionally, old burns. Many of these lands have limitations of soil or physiography that impair their value for agriculture. Many of these limitations, such as impeded drainage, shallowness, very coarse or very fine

textures, and low fertility, also affect tree growth and are emphasized in the guides. The special situations found on strip-mined lands are not considered.

Planting guides are much like maps; the simplest kinds show only major features without much detail. Maps of this sort are useful for orientation or for illustrating broad patterns, but they are of little value to anyone concerned about particular places. Forest planting, however, involves the long-term investment of money and effort in particular pieces of ground, and each of these may in one or several respects differ from adjacent pieces. Planting recommendations based only on broad generalities are not very helpful where soils, tree species, and plantation uses show the wide variety found in the Northeast. Therefore we have tried to match the detail of the guides to the complexity of actual planting situations.

Again like maps, planting guides are intended to show the user what to expect and how to locate himself in unfamiliar territory, although much remains to be discovered on the ground itself. Effective use of either a map or a guide requires some effort and training. The map user has learned to "read" both map and terrain, and to estimate distance and direction. Similarly, the guide user needs to know the significance of land form and slope and be able to "read" drainage, texture, and depth in a soil profile. Foresters can readily obtain sufficient knowledge of soils to use these guides. Some basic notions and simple judgments of soil properties must be learned, but the same kind of material is easily mastered by vocational agriculture students in "land judging" schools and contests.

The terms and definitions of the guides generally follow the Soil Survey Manual[3] and the common usage of soil science publications. This point is emphasized because many terms seem rather general until it is understood that they place exact meanings on phrases used more loosely in ordinary speech. For example, "loamy sand," in the guides differ significantly from "sandy loams," and these in turn from "silt loams." "Well drained" means specific evidence of good aeration throughout the profile and is not merely a cursory judgment of slope. Similarly, "moderate," "somewhat poor," "poor," and "very poor" are successive degrees of drainage inferred from profile and landscape conditions.

Planting guides are limited in accuracy by the availability of exact information. These guides and species ratings are tentative. They are based on combinations of research findings, soil surveys, judgment and experience, some quite local. Though they are the consensus of many informed individuals, undoubtedly these guides will be modified as further evidence accumulates. However, there are few areas where using these guides cannot improve planting site selection, and many serious errors now evident could have been avoided if such guides had been available and used in the past.

[3] Soil Survey Staff. Soil Survey Manual. U.S. Dept. Agr. Hdbk. 18. Washington. 1951.

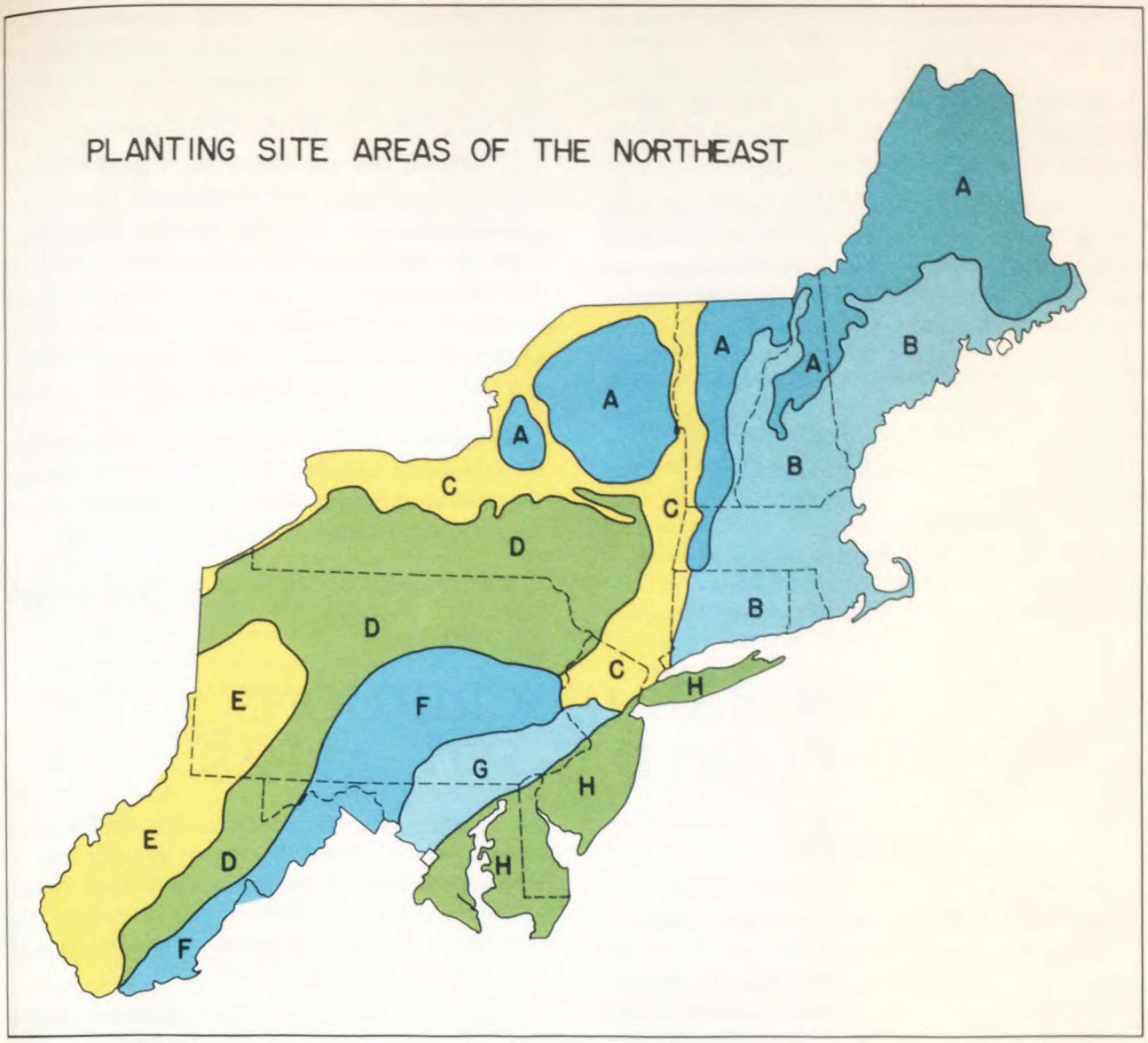
Area Subdivisions

The Northeastern region contains a wide range of climate, soils, and tree species. To reduce this range to manageable proportions the region was subdivided into eight areas based (see maps) on the major physiographic divisions followed by the Soil Conservation Service in their land-resource analysis. A separate guide, based on features believed to be most significant locally, was prepared for each area. The guide for West Virginia is based chiefly on effective soil moisture, and it differs from the others in structure. Nevertheless, it presents similar information. Near the boundary between two areas, users should test guides for both areas to determine which is more applicable.

Each area guide consists of a classification or key to the common planting situations or site units. A potential planting site is followed through the key by evaluating in sequence, one at a time, the several landscape and soil factors upon which the key is based; at the end point one or more species are listed as suitable for that site unit in which the keyed site seems to fit. If the evaluation of any factor is at all doubtful, alternative possibilities should be checked. As suggested in the notes with each key, the basic situations outlined in the key often require further appraisal of soil, local climate, or vegetative competition. A guide can never entirely replace skilled on-the-ground appraisal and local experience.

Since each site unit in these guides is a particular combination of soil and physiographic features, these units are closely related to the units of soil survey. Many, in fact, could be described just as well by use of soil-mapping units suitably grouped and then separated into *phases* according to major features, such as depth or erosion, that affect tree growth. A few soil series representative of each "situation" are listed to facilitate this correlation. Some series are broader than the situations described, but use of a series name implies only the types and phases compatible with the description given. In Area H, however, the guide leads directly to soil series and types as the complete "site unit."

For many of the site units, the guides show several species as suitable for planting. Many factors apart from soils and site enter into the choices among these more



or less suitable species. Like the sketches of monsters that adorn ancient maps, the notes attached to each guide give warning of various hazards to be avoided or overcome. The final choice of species is influenced by the products wanted, by the effort needed to establish and maintain a satisfactory plantation, and by critical insects and diseases. Though the guides cannot weigh these factors, they do emphasize the possibilities and limitations within which the choice can be made.

Species Ratings

The species are rated in three categories — suitable, not suitable, and limited suitability — according to soil and site adaptability. (Insects and disease problems may further limit actual recommendations.)

S (suitable) indicates that plantations of the species usually develop satisfactorily. Though growth may range from excellent to mediocre, no outstanding site hazards are known. The S' rating has the same significance, but it applies to species incapable of using the full growth potential of good sites. Such species may nevertheless be valuable for wildlife cover, windbreaks, landscape use, and the like.

N (not suitable) indicates that failures, poor growth, or short life are of such frequent occurrence that the species is a poor risk. The rating is often conservative, for mediocre and even good plantations of the species are occasionally found, especially on the more favorable variants (of drainage, moisture supply, etc.). Neverthe-

less, for N-designated species, the unit as a whole is hazardous.

L (limited suitability) indicates the need for caution. This rating is subdivided according to variations in field conditions and plantation values.

L* indicates that the species is adapted to the more favorable portions of the general situation described, though not to the unit as a whole. The "favorable conditions" must be judged in terms of the growth limitations of both the situation and the species.

For example, where average soil depth limits moisture supply, the additional moisture available through slope seepage or penetrable bedrock, or the protection of steep north and east aspects, may allow good growth in situations otherwise L- or N. Similarly, low fertility, drought, and frost are frequent hazards for some species on coarse-textured soils, soils depleted by past land use, or "frost pockets." The L* rating in such instances calls for on-the-ground appraisal. Similarly the growing conditions on imperfectly and poorly drained soils vary according to how long these soils are saturated each year and whether surface irregularities, like the tree-fall mounds of unplowed soils, are present.

L- indicates that the species has a good chance of developing on most of the unit described but that slow growth and certain site-related hazards, like drought injury or windfall, must be expected. These limitations also affect other species in greater or less degree. Though these sites may be undesirable for commercial timber production, frequently they will be planted for Christmas trees or for wildlife, watershed, and other purposes.

Ln applies to hardy species and to the nitrogen-fixing black locust. It indicates that growth will be adequate for cover or nurse crop, although the prospects of long-term survival or timber yield may be unsatisfactory.

Where existing information is inadequate or strongly conflicting, no rating has been given.

GENERAL DESCRIPTIONS OF PLANTING SITE AREAS

Area A

Area A approximately covers the northern spruce-fir and spruce-hardwood forest types. In New York, this includes the Adirondacks and Tug Hill and the surrounding area, mostly above 800-feet elevation. In New England, it includes the Green Mountains-Berkshire ranges, the White Mountains and outlying areas above 800 feet, and the northern two-thirds of Maine. Although elevations suitable for commercial timber production extend above 3,000 feet, the plantable areas considered are old fields and burns largely below 2,000 feet. The frost-free seasons are short, mostly less than 120 to 130 days, summers are cool, and late spring frosts general. Growing season (April-September) precipitation is chiefly above 20 inches.

The soils are mostly coarse- to medium-textured, but the effects of texture are often modified by large amounts of organic matter or, contrarily, by a large volume of stone or gravel in the profile. The finest textures, heavy silt loams and occasional clay loams, occur in Vermont and the river valleys of Maine. The coarsest textures are found in the extensive outwash deposits, but the glacial till from granites and similar rocks may be nearly as coarse. The till soils of the Adirondacks and northern New Hampshire are frequently loamy sands, but because of high organic content they appear as sandy loams and may be so treated on the guides. Shallow till soils are widespread, as are complexes of very shallow and deep. The effects of depth are sometimes modified by aspect and down slope seepage.

Planting in Area A is confined almost exclusively to conifers. The short growing season and frost hazard suggest the use of local seed sources or hardy races of exotic species, selected on the basis of local experience. Of the native species, black spruce, tamarack, jack pine, and pitch pine (the latter in the warmest portions of the area) have limited timber value but may be considered for cover where other species fail. The principal site variables are:

(1) Soil texture and origin. The excessively drained outwash soils are often too coarse and infertile for species other than pines and black spruce. On such soils small differences in silt and clay content may be important for growth.

(2) Depth and coarseness of the till soils. The most drought-susceptible areas again are suited only to pine, or can be left unplanted.

(3) Cultivation and fire. Sites that have been only pastured or lightly burned may still retain a considerable

surface organic layer which reduces the significance of coarse textures. Such sites should be upgraded in using the attached key. On poorly drained soils the numerous hummocks of tree-fall mounds of unplowed land provide better drainage conditions for trees than does formerly cultivated land.

(4) Fertility level. This is variously affected by texture, kind of rock, and the effects of fire or cultivation. Complete burning of the organic layers on strong podsols on outwash or coarse till, or long-continued cultivation, may severely reduce available fertility. The spruces, European larch, balsam, and red and white pines are known to suffer from nutrient deficiencies on such soils, and in places only the hardiest species will develop satisfactorily without fertilization. Such deficiencies have been observed in New York and New Hampshire but are rare in Vermont and northern Maine, possibly because admixtures of limestone, schists, or phyllites raise the fertility level of even the coarser soils.

(5) Poor drainage. The somewhat poorly and poorly drained soils are unsuitable for red and jack pines, and other species may suffer from sustained wetness, as well as from frostiness and heavy competition.

(6) Frostiness. Initial success on low-lying areas and level sands is often hindered by repeated frost injury, although the soils may be suitable. Hardiest species seem to be black spruce and red and jack pines.

Major planting-site difficulties in the past appear to have been:

- Use of unsuitable seed sources, especially with Norway spruce.
- Planting of Norway and white spruce on infertile, coarse-textured soils more suitable to pines.
- Nutrient deficiencies, for all species on some types of sandy soils.
- Use of small planting stock in heavy sod or brushy areas. On moist soils the effect of competition is particularly severe with balsam, spruce, and cedar.
- Planting of very shallow soils or poorly drained soils.
- Low planting standards, in combination with infertility, dry sites, and dry years.

Area B

Area B encompasses much of southern Maine, including all of the coastline; all of New Hampshire, except the mountainous portion; the Connecticut Valley portion of Vermont; all of Massachusets east of the Berkshire Mountains; Rhode Island; and all but the extreme western section of Connecticut.

The guide for Area H can be applied to the Cape Cod region if the climatic limitations of the species are properly considered. The guide for southern Area C can be used in comparable parts of Connecticut.

Elevations range from sea level to perhaps 1,000 to 1,200 feet, although numerous points of higher land are to be found. Annual precipitation ranges from approximately 34 to 56 inches, with an overall average of about 44 inches. The frost-free season varies from 130 to 200 days.

Outside of the Connecticut Valley, level land is strictly of local occurrence, and the prevailing topography is rolling to hilly. The rougher portions are usually very stony or bouldery and frequently are shallow over bedrock.

The soils belong to the Brown Podzolic great soil group and are characteristically acid and low in fertility. In the few instances where the soil is naturally fertile, productivity is sometimes low because of stoniness or lack of depth. Texturally the soils are on the light (coarse) side, ranging from the coarse gravelly sands of eskers and kames to silt loam, although the total acreage in either extreme is very small. Sandy loams and loams are the prevailing textures.

Planting is usually done on abandoned farm land, or land that may have been pastured at one time but now is occupied to a greater or lesser degree by sumac, juniper, hardhack, gray birch, and associated species.

Principal species usually planted are white and red pines, Norway and white spruces, and European larch. However, white spruce and red pine, as well as balsam fir, are recommended only for higher or cooler parts of the area, as noted in the guide. Of the hardwoods, yellow-poplar, white ash, and red oak are most commonly used, but hardwood planting is only a small fraction of the total. Other species planted in lesser quantities are: Scotch pine, jack pine (in the north only), hemlock, Japanese larch, white cedar, black locust, sugar maple, Douglas-fir, and balsam fir.

There are three main hazards to planting in Area B:

- Red pine planted within 20 miles of the coasts of Massachusetts, Rhode Island, and Connecticut is likely to be damaged severely by the European pine shoot moth. Considerable damage may occur farther inland.
- Spring frost in frost pockets, especially in the case of hardwoods.
- Shrub and brush competition.

Area C

This area is a belt of associated lowlands in New York and adjacent Vermont, embracing a considerable diversity of soils and climate. Although chiefly below 900 feet, it includes the limestone soils at higher elevations along the west side of the Black River (up to 1,300 feet) and south of the Mohawk River (up to 1,700 feet). These higher elevations and especially the higher portions of the northern loop are notably cooler than the remainder, and more subject to frost. (In such locations, use the Area A or D guides). With these exceptions the area has a relatively long frost-free season (150 to 180 days) and mild summer temperatures. Growing conditions are further modified near the large lakes and the ocean. The lower Hudson-New Jersey lobe of the area has a longer growing season and milder winter temperatures. Growing-season rainfall is generally favorable but drops below 15 inches in a fringe along Lake Ontario.

The soils vary widely. Many are influenced by limestones and calcareous shales, giving the area as a whole an intrinsic fertility that is reflected in its agriculture. The places that are most likely to be reforested are dominated by strongly acid loams to silt loams, often stony or gravelly, particularly in the Hudson Valley and near the boundaries with other areas.

Associated with some of these places are shallow and rocky soils and steep topography, where soil depth and aspect are often critical. Similar limitations characterize shallow limestone soils, and here the choice of species may be further restricted by the pH reaction. Lacustrine sands, silts, and clays deposited in glacial lakes are common and often are characterized by impeded drainage; in fact, impeded drainage should be suspected on any smooth or gently sloping site. Agricultural land is sometimes artificially drained and the discharge from tiles or ditches must be considered in planting associated slopes.

Sandy and gravelly soils are also common. Strongly podsolized soils on coarse materials occur along the north shore of Oneida Lake and as outwash deposits from the mountains in the Black River-St. Lawrence-Champlain loop. Elsewhere the sands and gravels have a different minerology, with greater inherent fertility, and are often fair to excellent sites for adapted conifers. Highly calcareous gravels are found locally in limestone areas, and many gravelly moraines and kames consist of a more or less acid and loamy surface over gravelly materials calcareous at shallow depths. When too steep or broken for agricultural use, such occurrences provide excellent forest sites despite their droughtiness for seedling establishment.

Area D

Area D consists chiefly of the Allegheny Plateau area of southern New York and northern Pennsylvania, but extends eastward to include the Catskills, and southward along the Allegheny Mountain tongue. Deep valleys and lowlands, below 800 feet in New York to 1,500 feet in West Virginia, are better treated as parts of the adjoining Areas C, E, or F. Elevations range above 3,000 feet at several points, but most of the planting sites are between 1,000 and 2,500 feet. Much of the area has a frost-free season of 120 to 150 days and a growing-season (April-September) rainfall of 20 inches. Both values increase southward and are also influenced by elevation.

The soils are chiefly derived from the underlying sandstones, siltstones, and shales, which usually are acid or very weakly calcareous. Lime-influenced soils are important only locally in the uplands, chiefly along the northern fringes of the Area, and on valley drift and occasional lacustrine areas of the glaciated portions. Otherwise, the dominant soils are quite acid and medium textured, most commonly loams and silt loams. Coarser textures are confined to water-laid deposits and some areas of sandstone and conglomerate bedrock. Finer soils occur where easily weathered shales predominate, and in localized areas of lacustrine or reworked lacustrine deposits. As a whole, however, the soils vary less here than in any other area.

Profile types vary throughout the area — moderate podsols, brown podsolics, acid brown forest soils and gray brown podsolics, with their poorly drained and alluvial associates. Differences in acidity, texture, and original vegetation are often associated with the characteristic soil series.

The significance of texture is modified by soil depth and its dilution with rock fragments. Many of the plantable soils have been mapped as stony (gravelly, channery, flaggy) or very stony, etc. Aside from planting difficulties, no exact significance for tree growth can be attached to such distinctions.

Soils with more than 50 or 60 percent coarse fragments (larger than 2 mm.) by weight probably should be considered equivalent to coarser textured soils in moisture retention and fertility. This reduction is sometimes offset by the loose consistence of gravelly subsoils, which allow deep root development.

Soil depth is often difficult to determine with exactness, except where hard bedrock lies close to the surface. On smooth uplands, transitions from deep to shallow soils may not be noticed unless outcrops are numerous.

In many areas the downward passage from soil to bedrock is not abrupt but extends through a variable depth of shattered rock or "congelifractate" containing some soil material. The accessibility of this zone for root development usually depends on good aeration in the soil above, and absence of pronounced gleying near the rock.

Internal drainage and subsoil consistence are the major factors limiting effective rooting depth. Dense subsoils (fragipans, "hardpans," compact till) at shallow depth are common on smooth topography. Their slow permeability impedes drainage, and excess water moves downslope along the subsoil surface creating temporary or "perched" water tables. Thus, the period of poor aeration is prolonged, not only on level areas but also on long slopes with otherwise satisfactory surface drainage. Depth to a restricting layer is a partial measure of rooting volume, although some species may extend small roots deeply into such layers. Many imperfectly and poorly drained soils become quite dry in normal summers, and the shallow-rooted vegetation may then suffer from drought.

Accordingly, the principal site variables are (1) Poor drainage, either seasonal or long continued, which rules out some species below certain limits. (2) Moisture supply, which is the product of soil texture and depth of unrestricted rooting and, occasionally, seepage or downslope flow. (3) Moisture demand, which is markedly higher on steep southerly and westerly slopes and less, of course, on northerly slopes. The effects of aspect are greatest on soils having a low moisture supply. (4) Fertility: no mineral nutrient deficiencies for the common conifers have been observed on the medium-textured soils, but can be expected on severely eroded sites and on soils from highly quartzose rock.

Black locust often responds to added phosphorus and potassium. Available nitrogen is an important limiting factor for the demanding hardwoods on old field sites; nitrogen deficiency, along with frost, animal, and insect damage, prevents satisfactory development of such hardwoods on most sites when planted by the usual methods. Hardwoods can be recommended only on inherently fertile sites or for special purposes such as sugar orchard or wildlife food, where cultivation or other cultural measures can be justified.

Successful reforestation in Area D has been handicapped by lack of adequate control for the white-pine weevil, thus reducing use of the most versatile and valuable conifer. The weevil has also restricted use of Norway spruce, a promising tree for soils of intermediate drainage. A further consequence of the weevil has been excessive use of red pine — often on soils unsuitable for it. Other sources of failure can be traced to overuse of black locust, unsuitable races of Scotch pine, and heavy sod competition that often overwhelms balsam fir, white cedar, and spruce of the sizes commonly planted. The common occurrence of imperfectly drained soils and the wide use of untested exotics (Scotch and Austrian pines, white and Norway spruces, larches, Douglas-fir) will no doubt continue to present site problems.

AREAS D, E, AND F IN WEST VIRGINIA

Area D

This is the high Allegheny Plateau in West Virginia, lying at elevations from 2,000 to 4,000 feet. The climate is cool; the growing season is 150 to 170 days; and the rainfall ranges from 40 to 50 inches. The topography consists of steep mountains and high plateaus. Farming is mostly in the valleys, and on the scattered plateau areas. Strip mining has contributed to the abandonment of numerous farms.

The principal soils are Dekalb, which ranges from shallow to moderately deep; the moderately deep, well-drained Gilpin; and the moderately well-drained Wharton and Ernest. Much of the woodland is stony. The most extensive areas needing reforestation are on the Gilpin and associated soils.

Natural woodlands are made up mainly of mixed oaks, hard maple, cherry, beech, birch, and some white pine and yellow poplar. Old field species are mostly red maple, hickory, yellow-poplar, and some white pine and Virginia pine. Red spruce and balsam fir occur at the very high elevations.

Area E

This is the thoroughly dissected Appalachian Plateau area of western West Virginia. The topography is very hilly, with many "benched" slopes. Rainfall averages

from 40 to 50 inches, with a growing season of 150 to 180 days. Elevations are mostly between 600 to 1,500 feet.

The principal soils are the well-drained, deep Westmoreland and the moderately deep Gilpin in the northern part, the deep, heavy textured Upshur-Gilpin (Meigs) soils in the west-central part, and the moderately deep Muskingum soils on extremely steep slopes in the southwestern coal fields.

Erosion is severe in many places, particularly in the Upshur-Gilpin section. Many very steep, severely eroded former pastures are being abandoned, and are growing up in second growth of a variety of species. Since the Upshur-Gilpin soils mostly are deep, their moisture-holding capacity is good. The reforestation needs are greater in this section than in any other part of the state.

The extremely steep southern coal field section is almost entirely forested. The woodlands are characterized by yellow-poplar, white oak, and mixed oak stands, with some ash, beech, elm, pitch pine, and shortleaf pine. Abandoned fields usually seed in to Virginia pine, yellow-poplar, elm, and red maple.

Area F

In West Virginia, this area takes in all land east of the Allegheny Front. The principal physiographic divisions are the Great Limestone Valley, the Potomac Ridges and Valleys, and the Allegheny Mountains; lesser ones are the Greenbrier Limestone Valley and the southern West Virginia shale ridges.

Elevations range from about 400 to 4,800 feet. Precipitation is from 30 to 45 inches, with much of the area receiving less than 35 inches. Topography is gentle in the limestone valleys; moderately steep, with short irregular slopes, in the shale ridge area; and very rugged in the mountains.

In the limestone valleys, the main soils are the deep, well-drained Hagerstown, Frankstown and Frederick series. In the shale ridges, however, the shallow to very shallow Ashby, Litz, and Galvin soils predominate; and in the mountains, the shallow to moderately deep Dekalb soils, derived from sandstone, are extensive.

The largest areas needing reforestation are on the shallow shale soils. Most of the mountainous areas are already in forest, while the limestone valleys have little need of reforestation.

The woodlands are characterized by chestnut oak, scarlet oak, Virginia pine, white oak, and some red and black oak on the better sites. Mixed oaks are common on the higher mountains. Virginia pine, hickory, and white oak invade many old-field areas.

Forest Planting In West Virginia

Planting forest trees is, and will continue to be, a relatively large undertaking in Areas D, E, and F in West Virginia. Of the 15½ million acres comprising the three areas, about a million acres need to be reforested.

The planting sites are mainly poor or wornout farmland, much of it steep. Erosion, especially in Area E, is common. Some natural seeding is occurring, but often to undesirable species. Planting is required to bring these sites into production without prolonged delay.

Although hardwoods do have some place in planting programs, conifers are recommended for most sites. For hardwood species, except black locust, the site should be of high quality, with only a thin sod or none. Frost areas should be avoided. Protection from animals such as rabbits, deer, and mice usually will be necessary.

Recent work on hardwood planting at the West Virginia Agricultural Experiment Station indicates that most hardwood species start best under light vegetative cover or in forest openings. Heavy cover, of course, is unfavorable. Black locust should always be grown in the open and, unlike the other hardwoods, is suitable for planting on dry, infertile, or eroded soils. Black cherry will grow at nearly all elevations in the state, but commonly develops poor form at the lower elevations and therefore is not recommended below 2,000 feet.

Frost is a serious damaging agent. The winters tend to be open in Areas E and F, with little continuous snow cover. As a result, frost heaving is common, especially on the heavier soils. This requires that planting be done mainly in the spring. Spring frosts often seriously damage the new top growth of hardwoods, European larch, and the mountain forms of Douglas-fir.

More white pine is planted for timber production than any other species. The most serious damaging agent is white pine blister rust. The white-pine weevil, though present, has not yet become a serious pest.

Red pine plantings are now limited to the higher elevations because of damage elsewhere by the European pine shoot moth. Shortleaf pine is a good timber species for the warmer sections of Areas E and F. Lack of technical knowledge about handling the species is believed to account for the rather high incidence of failures with this species in the past. Virginia pine is a good pulpwood species and grows relatively well on poor, dry sites.

Norway spruce is a useful timber species on suitable sites over a wide range of elevations. It requires fairly fertile, moist soils. Site is less critical when the species is

Table 1.--Planting site classification for areas D, E, and F in West Virginia

(Numbers indicate moisture regime; letters indicate soils group)

Area and aspect	Drainage class	Texture	Slope position	Soil depth and slope								
				Very shallow (6-12 inches) Slope (percent)			Shallow (12-24 inches) Slope (percent)			Deep (24+ inches) Slope (percent)		
				0-20	20-40	40+	0-20	20-40	40+	0-20	20-40	40+
SLOPES AND BOTTOMS Northeast	Well and moderately well drained	Coarse	Upper	4	4	4	4 h	4 h	4 h	3 h	4 h	4 h
			Middle	4	4	4	3 h	3 h	4 h	3 h	3 h	3 h
			Lower	--	--	--	3 h	3 h	3 h	2 hm	3 h	3 h
		Medium to fine	Upper	4 j	4 j	4 j	3 efgk	3 efgk	4 efgk	2 abdefg	2 abdefg	3 abefg
			Middle	4 j	4 j	4 j	2 efgk	2 efgk	3 efgk	2 abdefg	2 abdefg	2 abefg
			Lower	--	--	--	2 efgk	2 efgk	2 efgk	2 abdefgcl	2 abdefgc	2 abefgc
	Somewhat poorly drained	Coarse	Middle & Lower							2 to 2-		
	Imperfectly drained	Medium to fine	All							2- n		
	Poorly and very poorly drained	Medium to fine	Middle & Lower							1 p		
Southwest	Well and moderately well drained	Coarse	Upper	4	4	4	4 h	4 h	4 h	3 h	4 h	4 h
			Middle	3	4	4	4 h	4 h	4 h	3 h	3 h	4 h
			Lower	--	--	--	3 h	3 h	3 h	3 h	3 h	3 h
		Medium to fine	Upper	4 j	4 j	4 j	3 efgk	4 efgk	4 efgk	2 abdefg	3 abdefg	4 abefg
			Middle	4 j	4 j	4 j	3 efgk	3 efgk	3 efgk	2 abdefg	3 abdefg	3 abefg
			Lower	--	--	--	2 efgk	3 efgk	3 efgk	2 abdefgcl	2 abdefgc	3 abefgc
	Somewhat poorly drained	Coarse	Middle & Lower							2		
	Imperfectly drained	Medium to fine	All							2 n		
	Poorly and very poorly drained	Medium to fine	Middle & Lower							1 p		
RIDGES	Well drained	Coarse		4			4 h			3 h		
		Medium to fine		4 j			3 efgk			2 bdefg		
	Imperfectly drained	Coarse		--			--			2		
		Medium to fine		--			3			2		
	Poorly drained	Coarse		--			1			1		
		Medium to fine		--			1 p			1 p		

Moisture regime

1 = Wet 2 = Moist

3 = Dry 4 = Very dry

Key to texture

Coarse = Loamy sand to fine sandy loam

Medium to fine = Very fine sandy loam to clay

Special conditions: This classification will be modified by special conditions that change the moisture relationships. These are:

1. Where the area is heavily eroded, increase the moisture class number by one, in moisture classes 2 and 3.
2. Where slope is terraced or benched (as frequently is the case in southern and eastern West Virginia) reduce by one moisture class number areas falling in class 3.
3. Where the soil type is Ashby, increase ratings of 2 or 3 by one class number.
4. The following areas should not be planted to trees for a forest crop: (1) pH less than 4.1, (2) depth to bedrock less than 6 inches.
5. Soils with pH over 6.5 restricted to the hardwoods, eastern red cedar, pitch pine, and the larches.

Table 2.--Adaption of species according to soil moisture regime for Areas D, E, F in West Virginia

(S = suitable, L = limited suitability, N = not suitable)

Species	AREA D with soil moisture regime of--				AREA E with soil moisture regime of--				AREA F with soil moisture regime of--			
	1	2	3	4	1	2	3	4	1	2	3	4
Conifers:												
Jack pine (above 2000')	N	S	S	S	N	N	N	N	N	S	S	L
Pitch pine	N	S	S	S	N	S	S	S	N	S	S	S
Red pine (above 2000')*	N	S	S	S	N	N	N	N	N	S	S	S
Shortleaf pine (below 1500')	N	N	N	N	N	S	S	S	N	S	S	L
Virginia pine (below 2500')	N	S	S	S	N	S	S	S	N	S	S	S
White pine*	S	S	S	S	S	S	S	L	S	S	S	S
Norway spruce*	L	S	L	N	L	S	L	N	L	S	N	N
Red spruce (above 2500')	S	S	N	N	N	N	N	N	N	N	N	N
European larch	S	S	L	N	S	S	L	N	S	S	N	N
Japanese larch	S	S	L	N	S	S	L	N	S	S	L	N
Eastern red cedar**	N	N	N	N	N	S	S	L	N	S	S	L
Eastern hemlock	S	S	L	N	S	S	L	N	S	S	N	N
Hardwoods:												
Black cherry	N	S	L	N	N	N	N	N	N	S	N	N
Black locust	N	S	S	S	N	S	S	S	N	S	S	S
Red oak	N	S	L	N	N	S	N	N	N	S	N	N
White ash	N	S	L	N	N	S	N	N	N	S	N	N
Yellow-poplar	N	S	L	N	N	S	N	N	N	S	N	N
Christmas trees only:												
Balsam fir (above 1500')	S	S	N	N	N	L	N	N	N	S	N	N
Douglas-fir (below 3000')***	N	S	S	N	N	S	N	N	N	S	L	N
White spruce (above 1500')	N	S	L	N	N	S	N	N	N	S	N	N
Scotch pine	N	S	S	S	N	S	S	S	N	S	N	N

*Suitable also for use as Christmas trees. **For eroded limestone soils. ***Mountain form.

grown for Christmas trees, in part because competition usually is well controlled in Christmas-tree culture. Seed source is an important factor in the performance of Norway spruce.

Scotch pine has proved valuable over much of the state for Christmas trees, but is not recommended for timber production.

Using the Tables for Areas D, E, F in West Virginia

Tables 1, 2, and 3 have been prepared for determining the species that may be planted under various conditions in Areas D, E, and F in West Virginia. Table 1 classifies the various site conditions by topographic features and soil depth. The numbers in the cells indicate the soil-moisture regime, which in part reflects site quality. A value of 1 is wet, 2 is moist, and 4 is very dry. Thus a site having a well-drained, fine-textured shallow soil on a 15-percent lower slope of northeast aspect is given a rating of 2, which indicates a moist site.

The small letter or letters in the cells beside the soil-moisture regime number indicates the soil group. A brief description of the soil groups and representative soils is presented in table 3. This table, developed particularly for persons well versed in soil types, is a supplemental aid in determining soil-moisture regime in table 1. However, persons who are not familiar with the soil types may ignore them and still use table 1 effectively for determining soil-moisture regime.

The next step, after finding the soil-moisture regime for the planting site, is to determine the species that may be planted. This information may be obtained from table 2. The area where the planting site is located should be determined from the map (page 3). Then,

Table 3.--Soil groups as a basis for tree planting

Soil group	Description	Representative soils
a.	Deep, well drained, medium and heavy textured limestone soils. High available moisture capacity.	Hagerstown, Frankstown, Frederick.
b.	Deep, well drained, acid upland and terrace soils. Moderate available moisture capacity.	Rayne, Ungers, Holston, Wellston, Clymer.
c.	Deep, well drained and moderately well drained, acid and alkaline influenced colluvial soils. High available moisture capacity.	Shelocta, Laidig, Mench, Brookside, Vandalia, Hayter, Vira, Ernst, Clarksburg, Kedron, Landisburg.
d.	Deep, moderately well drained upland and terrace soils. Moderate available moisture capacity.	Cookport, Wharton, Guernsey, Captina, Pickaway, Monongahela, Tilsit.
e.	Shallow to moderately deep, well drained, medium textured, upland soils. Moderate available moisture capacity.	Gilpin, Calvin silt loam, Muskingum silt loam, Dekalb loam, silt loam.
f.	Shallow to moderately deep, well drained, medium textured, upland soils.	Ashby silt loam, channery silt loam.
g.	Moderately deep, medium to heavy textured, well drained, mixed alkaline and acid shale uplands. Moderate to high available moisture capacity.	Westmoreland, Teas, Edom, Litz silt loam, Meigs, Belmont, Elliber, Upshur.
h.	Shallow to moderately deep, well drained, sandy acid soils. Low available moisture capacity.	Dekalb, Muskingum sandy loam, Lehew sandy loam, Leetonia.
j.	Very shallow, well drained, shale soils. Very low available moisture capacity.	Ashby shaly silt loam, Litz shaly silt loam, Berks shaly silt loam.
k.	Shallow and very shallow limestone soils. Low available moisture capacity.	Berkeley, Corydon.
l.	Deep, well drained to imperfectly drained, medium textured, bottomlands. High available moisture capacity.	Pope fine sandy loam, Sequatchie fine sandy loam. Pope gravelly loam.
m.	Well drained, sandy bottomlands. Moderate available moisture capacity.	Tyler, Cavode, Brinkerton, Blairton, Colbert, Loysville, Nolo, Wyatt.
n.	Somewhat poorly drained, slowly permeable soil. Low available moisture capacity.	Atkins, Lickdale, Melvin, Guthrie, Burgin, Robertsville, McGary.
p.	Poorly drained soils. Low available moisture capacity.	

with the soil-moisture regime already known, the species that will grow there are indicated by S or L in the table. For example, a landowner in Parkersburg on the Ohio River wishes to know the species suitable for planting on a certain old field. He has determined from table 1 that the soil-moisture regime is 4. Then from the map he determines that the field is in Area E. Now turning to table 2 he finds for his area and soil-moisture regime that pitch pine, shortleaf pine, Virginia pine, black locust, and Scotch pine are suitable species. White pine and eastern red cedar have limited use. Then, depending upon the crop he wishes to raise and the availability of stock from forest nurseries, he may select one or more species for planting the field.

GENERAL DESCRIPTIONS OF AREAS F, G, AND H

Area F

Appalachian Ridges and Valleys

Area F, comprising about 10.4 million acres, is a highly distinctive unit, physiographically and geologically. The outstanding feature is the ridge and valley terrain, which came about through a severe and widespread folding of the earth's crust. This belt of ridges and valleys, oriented in a general northeasterly-southwesterly direction, attains its greatest width in Pennsylvania. The eastern part of the province comprises the Great Limestone Valley — an area of fertile soils and productive farms. Westward from this Great Valley lie a series of steep ridges and narrow valleys—a formidable barrier to east and west travel, as is strikingly revealed on Pennsylvania road maps.

Geologic erosion and, in some sections, glaciation have removed the less resistant strata from the ridges, exposing highly resistant conglomerates, sandstones, quartzites, and slates. Softer limestones and shales are found in the valleys. East of the Susquehanna, notably in the vicinity of Pottsville, anthracite coal seams underlie some of the valleys and outcrop on the slopes of the ridges on either side. Topography varies within the area from nearly level to very steep. In general, sandstone ridges are characterized by moderately steep to very steep slopes, whereas shale and limestone formations are associated with gentler topography.

Climate varies considerably from place to place because of rough topography and elevations ranging from 220 to more than 2,000 feet. Average frost-free periods range from 140 to 170 days. July temperatures average about 70°F. in some sections and up to 75° or higher in others. Precipitation does not vary so much, however: about 40 inches annually, of which about 22 inches falls during the growing season. Winters are more or less open, with mean January temperatures of 24° to 30°F.; in the northern and western parts of the area the winters are colder and snow tends to persist over longer periods.

In the broader valleys of the Susquehanna River and its major tributaries, the parent soil material is alluvium deposited in flood plains and terraces. The area east of the Susquehanna was glaciated in pre-Wisconsin time, with the result that parent materials are composed mainly of the mixed and transported detritus of local rocks, varying greatly in depth. Elsewhere the parent materials and soils have developed in place, for the most part, except adjacent to some of the mountains and ridges. There, areas of sandy and gravelly or stony colluvium overlie shale or limestone materials.

The soils are principally loams, sandy loams, and silt loams, with some clay and silty clay loams, and occasional loamy sands. The coarser soils commonly are gravelly and many are stony. Most of the soils are well drained or, on lower slopes, moderately well drained. The shallow soils of ridges and steep slopes, and many of the shallower valley soils, particularly those of shale origin, are droughty and may be classified as excessively or somewhat excessively drained. There are some poorly drained soils, but these tend to be patchy and make up only a small part of the total area.

Soil depths are highly variable throughout the area, ranging from very shallow to deep. Shallow soils are prevalent on the sandstone ridges; deeper soils are most often found on lower slopes and bottoms. Upland soils exhibit low to moderate levels of fertility; whereas valley soils range from moderate to high, reflecting differences in parent materials., Typically, limestone soils are the most fertile.

Soil erosion is widespread, though varying greatly according to slope and cover, land use, and parent material. The steep sandstone ridges are forested and show little erosion unless burned or heavily logged. Sheet erosion often follows fire, and gullies commonly develop in skidways and temporary roads after logging. Many of the shale and limestone areas have long been in cultivation or pasture, and commonly show moderate to severe erosion, except on the gentlest slopes.

Area G

Triassic Basin, Lancaster Limestone Valley, and Piedmont Plateau

Area G, comprising about 5.4 million acres, includes all or part of three more or less distinct physiographic provinces lying at elevations lower than Area F. The dominant one, in position and proportion of the total, is the Triassic Basin. This is a belt of weak sedimentary rocks extending from the lower Hudson Valley across northern New Jersey and Pennsylvania into Maryland; the landscapes are gently rolling without strong relief,

except for the occurrence of ridges of diabase, locally called ironstone, throughout the basin. These ridges represent igneous intrusions exposed by geologic erosion. Sedimentary rocks adjacent to the igneous masses usually have been metamorphosed into slate.

Southeast of the Triassic Lowland is the Lancaster Limestone Valley. This centers around the town of Lancaster, with prongs extending southwestward across the Susquehanna to the Maryland border, and eastward in a narrow strip across Chester and Montgomery counties. It is a lowland area of gentle relief and rich agricultural soils; about five-sixths of the area is farmland.

Farther to the southeast is a belt of Piedmont extending from near Trenton across the corner of Pennsylvania into Maryland and southward. This is a section of low hills and gentle relief. Rock formations are principally gneisses, schists, and quartzites with small areas of various other rock types.

The climate of Area G is mild and humid. Frost-free days vary from 160 to 200. Mean daily July temperatures range in the mid-70's. Winters are generally open, with daily January temperatures averaging near 32°F., or slightly higher. Annual rainfall averages between 40 and 46 inches, with half or slightly more falling during the growing season.

Practically all the soils in Area G have developed in place. With the considerable variety of parent materials represented, the soils are varied. The limestone and calcareous schists of the Lancaster Limestone Valley give rise to deep, fertile, fine-textured and well-drained soils that are among the best farming soils in the East. Despite the comparatively gentle relief, however, there has been considerable erosion during some 200 years of agriculture.

Soils of the Triassic Lowland have developed from shales and sandstones, diabase, and slate. The shale soils range from very shallow to deep, mostly shallow to moderately deep; they are well drained and of moderate fertility. Sandstone soils commonly are found on the relatively low hills and ridges; most of them are moderately deep, well or somewhat excessively drained. Many are forested and consequently are not badly eroded. Soils of the diabase or ironstone ridges are high in fertility, mostly well drained and moderately deep, and support good growth of forests. Associated slate soils bordering these ridges often are shallow, low in fertility, and more or less poorly drained.

The Piedmont soils originating from gneisses, schists, and quartzites are mostly deep, and well or moderately well drained on lower slopes; on steeper or middle and upper slopes, they usually are well drained but only moderately deep. Some localized areas of impeded drainage occur. Textures are variable and fertility levels moderate. Cultivated areas commonly have undergone moderately severe erosion.

Area H

Area H comprises the Delmar Peninsula and the coastal plain of New Jersey, Pennsylvania, and Maryland. Although southern Long Island is included in Area H, rapidly expanding suburbanization onto possible planting sites precludes much reforestation. Cape Cod, Nantucket, and the eastern half of Martha's Vineyard are also included in the Lakewood-Dukes soil association found in parts of Area H, and these sections may be referred to in either Area B or Area H, with allowance for temperature differences.

Area H is under the influence of the Atlantic Ocean and thus has a maritime climate marked by mild winters and warm summers. The rainfall is evenly distributed throughout the year and averages from 48 inches in New Jersey to 40 in Maryland. The average number of days without killing frost ranges from 180 days in New Jersey to 210 in southern Maryland. Prevailing winds flow from the west, although occasional and destructive tropical disturbances approach from the south and southeast.

The greatest proportion of the soils are derived from unconsolidated materials. Minor sections of intrusive igneous formations make up the parent materials of several small and isolated soil series. The soils of southeastern New Jersey and east-central Delaware are, for the most part, excessively drained, coarse-textured sands and loamy sands. To the west and south of these areas, the soils contain increasing quantities of silt and clay, forming sandy loams and loams.

All the soils of Area H are acidic, with an average of pH 5.2 to 5.5. In general, the terrain is flat to slightly undulating and erosion is negligible. Organic matter is very low in most soils, litter decomposition is rapid, and all timbered sections are subject to damage by wildfires, which are often severe.

The long growing season and mild winters permit planting in both fall and spring, but existing nursery schedules and the seasonal labor supply practically eliminate the fall planting. As in other areas, the planting stock is predominantly coniferous. Some 20 to 30 years ago both red pine and Scotch pine were widely planted in New Jersey, but they have fallen into disfavor because of shoot moth and tip moth damage. Today the most popular species are Norway spruce, Japanese larch, and

white, Austrian, pitch, and shortleaf pines; and the "fence-post tree" — black locust. Scotch pine, being planted as a Christmas tree, requires intensive treatment. In Maryland and Delaware, loblolly pine is regarded as the most promising plantation species, even in drier areas that normally support shortleaf and Virginia pines. Christmas tree plantations are not recommended for the wet areas of southern Maryland.

The forested regions of Area H are usually stocked with enough mature trees to provide seed for future stands, but removal of the best formed trees followed by destructive wildfires have reduced many stands to inferior scrub. The practice of prescribed burning to convert these low-quality oak-pine stands to pine is supplemented by planting only when natural reproduction is inadequate.

The huge areas of abandoned land found in other sections of the Northeast simply do not exist in Area H. Future planting, therefore, should be devoted to improving the present forests with strains of known genetic superiority. Various sawflies (Neodiprion) attack and at times are extremely destructive to the pines of the area, but chemical and biological control measures are limiting the damage. Deer browsing will have to be controlled by more effectively regulated hunting if planting is to succeed. Still, the most serious obstacle to successful reforestation is the lack of after-planting silviculture, which has the psychological effect of discouraging further planting.

AREA A

Guide to Planting Site Classification and Species Adaptation

SITE CRITERIA					SPECIES																		NOTES ON SITES
																				Christmas trees			
Drainage condition	Texture and depth	Other significant features	Site unit no.	Representative soil types	Jack pine	Pitch pine	Scotch pine	Red pine	White pine	Black spruce	Red spruce	White spruce	Norway spruce	European larch	Japanese larch	Tamarack larch	White cedar	Hardwoods	Balsam fir	White spruce	Douglas fir	Scotch pine	Austrian pine	
I. Excessively to somewhat excessively drained; shallow soils or sands and gravels. "Dry sites."	A. Shallow acid soils, usually over acid bedrock, without sustained seepage.	a. Average depth of plantable soil (exclude ledge) less than 20" over solid bedrock, or less than 10" over well fissured rock.	1	Shapleigh, Canaan, Thorndike, Lyman, Hollis sl and l.	L⁻	L⁻	L⁻	L⁻	L⁻	L⁻	N	N	N	L⁻	N	L⁻		N	N	N	N	L*	Variable productivity; cool aspects, surface humus, seepage, or penetrable substrate upgrade these sites.
	B. Shallow high lime soils, usually over limestone.	a. Average depth of plantable soil (exclude ledge) less than 20" over solid bedrock, or less than 10" over highly fissured rock.	2	Shallow phase Dover l.	N	N	L*	N	L*		N	L*		L*	N		L⁻		N	L*		L*	L*	As above. Calcareous surface limits conifers to Austrian pine, and cedar.
	C. Loose acid sands, loamy sands and gravels; mostly stratified. Sand plains, terraces, eskers and very sandy till. (If gravel and rock 50% by volume include with 1).	a. Blow sands and washouts. (Place uneroded areas with shallow overblow or overwash, with #4 or 5).	3	Severely eroded Adams, Hinckley, Windsor ls.	Ln	Ln	Ln	L⁻	N	N	N	N	N	N	N		N	N						Often highly variable, with mixed areas of erosion and deposition. Stabilization and fertilization often needed.
		b. Deep, coarse sands to loamy sands without fine layers, plowed; or unplowed podzols burned to mineral soil. Infertile sites; ground cover of mosses or poor shrubs.	4	Adams, Colton, Hinckley, ls.	Ln	Ln	L⁻	L⁻	L*	Ln	N	N	N	L*			N	N		L*		L*		Separate 4 from 5 on basis of local experience and indicators. Fertilization often needed for satisfactory Christmas tree production and sometimes for plantation establishment. On sand flats severe frosts may limit early survival and growth.
		c. Deep, coarse to fine loamy sands not deteriorated by treatment. May have fine sand or silt layer at 3 - 8'. Fair fertility; ground cover of grasses, shrubs.	5	Adams, Colton, Hinckley, Windsor, ls. and lfs.	S'	S'	S'	S	S	S'	L*	N	L*	S	S	S'	L⁻	N	L*	L*	N	S	L*	
II. Well to somewhat excessively drained. "Well drained sites".	D. Moderately coarse textured acid soils; loamy fine sands, sands with fine layers, very gravelly loams; also moderately deep soils not included in #1.	a. Water laid fine and very fine sands, and sands with finer layers beneath.	6	Suffield, Windsor, Hinckley, lfs.	S'	S'	S'	S	S	S'	L*	L*	L*	S	S	S'	L⁻	N	L*	L*	L*	S	S	These two units similar in adapted species. Productivity varies with moisture supply and fertility. Fertilization may be needed for Christmas trees.
		b. Very gravelly and coarse sandy loam tills, and deeper variants of #1.	7	Herman gr. csl.; Thorndike gr.l., mod. deep.																			

Continued

Area A, continued

SITE CRITERIA					SPECIES																				NOTES ON SITES
																					Christmas trees				
Drainage conditions	Texture and depth	Other significant features	Site unit no.	Representative soil types	Jack pine	Pitch pine	Scotch pine	Red pine	White pine	Black spruce	Red spruce	White spruce	Norway spruce	European larch	Japanese larch	Tamarack larch	White cedar	Hardwoods	Balsam fir	White spruce	Douglas fir	Scotch pine	Austrian pine	
III. Well to moderately well drained soils. Mostly "well drained sites", with better moisture retention than II because of texture or fragipans.	E. Sandy loams to fine sandy loams. Often bouldery or gravelly.	a. Acid; pH usually 5.5 or less in lower B horizon. Coarse fragments < 1/2 soil volume; (If > 1/2, treat as # 7)	8	Herman, Gloucester, Becket sl. Agawam, Melrose lfs.	S'	S'	S'	S	S	S'	S	S	S	S	S	S'	L⁻	N	S	S	L*	S	S	
	F. Very fine sandy loams to silt loams, or lime influenced sandy loams.	a. (If eroded, of low fertility, or if coarse fragments > 1/2 soil volume, treat as #8).	9	Melrose v. fsl., Essex l., Plaisted sil. Woodbridge l.	S'	S'	S'	S	S	S'	S	S	S	S	S	S'	S	L*	S	S	L*	S	S	
IV. Somewhat poorly to poorly drained soils, "Fresh" to "Moist" sites.	G. Lacustrine and marine silts and clays.	a. (Poor drainage or compaction of surface by grazing reduces suitability).	10	Scantic sil.	Ln	Ln	S	N	S			S	S	L*	L*		S	L*	S	S	N	S		If surface above pH 7, limit conifer to white spruce, and cedar
	H. Sandy loams to loams and silt loam tills.	a. Finer textures or higher base status.	11	Cabot l, Marcy sil.	Ln	S'	L*	N	S	S'	L*	S	S	S	S	S'	S	L*	S	S	N	S		Ln and L* indicate suitability on better drained portions if pH satisfactory.
		b. Coarse textures or lower base status.	12	Westbury l, Dixmont (SWP) sil.	Ln	S'	L*	N	S	S'	S	S	S	S	S	S'	L*	N	S	S	N	S		
V. Swamps and very poorly drained soils. "Wet sites."	I. Waterlaid loamy sands and very gravelly sandy loams; usually level outwash.	a. Usually infertile, with restricted rooting.	13	Saugatuck, Walpole csl.	N	Ln	L*	N	L*	S	S	L*	L*	L*	L*	S		N	L*					Often subject to severe frost. L* refers to more favorable conditions of drainage and fertility. Uncultivated microrelief often upgrades site.
	J. Materials of any texture or depth; also peats.	a. Largely nonplantable. Treat better areas as under IV.	14	Whitman, Scarboro l.				N	L*	S	L*	L*		N	N	L*		N		L*	N	L*	N	

Legend

S - Suitable
- S Suitable; sites I to III.
- S' Suitable, but often better to plant more valuable species

L - Limited
- L* Suitable on the more favorable conditions to texture, aspect or drainage within the unit. Also, in reference to Christmas trees, suitable with added culture or fertilization. Remainder of unit L⁻ or N.
- L⁻ Suitable but slow growth likely; sites IV to V.
- Ln Suitable as a nurse or for cover only. Long term survival or yield uncertain.

N - Not suitable

Notes on species

JP - Hardy species for infertile or frosty sites.
PP - For coarse soils at low elevations or warm sites.
SP - Hardy species for dry and infertile sites. Use suitable seed sources; prefer RP where suitable.
RP - Plant only on well drained and better moderately well drained soils.
WP - Weevil or blister rust may forbid. Versatile as to site but influenced by infertility, frost pockets and very poor drainage.
BS - Resistant to frost, infertility, poor drainage. For cover, not timber production.
RS - Little is known of its planting but this species seems to grow on any soil with a surface raw humus layer. Otherwise only on medium to good acid sites.
WS - Tolerant of drainage and high lime; sensitive to low fertility.
NS - Few satisfactory plantations within Area A. Affected by white pine weevil, frost, fertility and very poor drainage. Suitable provenance essential.
EL & JL - Little is known of Japanese Larch in Area A. Suitable provenances of European adapted to medium fertility, moderate to good drainage. European more tolerant of dry sites. Both sensitive to late frosts.
Tam. - As black spruce; primarily as cover where better species unsuitable.
WC - Slow growing but tolerates wetness and high pH. Planting failures often due to heavy competition.
Hdwd. - In general, hybrid poplar and other hardwoods are worth planting only on better sites, with adequate preparation and protection.

For Christmas trees:

Bal. & WS - Versatile, hardy species but on coarser soils may require fertilization for suitable growth and color.
DF - Frost sensitive and subject to needle cast (Rhabdocline). Select hardy seed origins and restrict to sites with good soil and air drainage.
SP - Very hardy species but foliage may discolor on coarsest soils. Select seed origins with good winter color and other characteristics.
AP - Tolerant of drought and high lime; more sensitive to frost than other pines.

AREA B

Guide to Planting Site Classification and Species Adaptation

SITE CRITERIA					SPECIES															Remarks[2]
																	Christmas trees			
Moisture relations	Texture[1] and depth features	Other significant features	Site unit no.	Representative soil types	Scotch pine	Pitch pine	Jack pine	Red pine	White pine	Hemlock	E & J larch	Norway spruce	White spruce	White cedar, Thuja or Chamecyparis	Black locust	Red oak	Sugar maple, Tulip poplar, White ash	Douglas fir	Balsam fir	
I. Excessively drained.	A. Coarse and very coarse textures; gravel and coarse sands (includes most kames, eskers and dunes).		1		Ln	Ln	L⁻	L⁻	L⁻	N	N	N	N	N	Ln	N	N	N	N	Growth better on silty gravels or where fine layers occur within 6'.
	B. Medium coarse texture (loamy sand, coarse sandy loam); deep.	a. S & W slopes	2	Hinkley, Jaffrey, Colton	S'	S'	S	S	L*	N	L*	N	N	N	Ln	N	N	N	N	
		b. Level; N & E slope	3		S'	S'	S	S	S	S	L*	L*	L*	N	Ln	L*	N	L*	N	
	C. Shallow, usually less than 20" to bedrock; sandy loam to silt loam.		4	Hollis, Shapleigh	L⁻	L⁻	L⁻	L⁻	L⁻	N	L*	L*	L*	N	Ln	N	N	L*	L*	Highly variable. Moisture supply increases with finer textures, penetrable bedrock, or steep N and E slopes. On such sites L⁻ and L* ratings approach S.
II. Well and moderately well drained	A. Medium coarse to medium texture (sandy loam to loam), usually more than 30" to bedrock.	a. S & W slopes	5	Gloucester, Hermon, Merrimac, Charlton	S'	S'	S'	S	S	L*	S	S	L*	N	S'	S	L*	S	L*	
		b. Level; N & E slopes	6		S'	S'	S'	S	S	S	S	S	S	N	S'	S	L*	S	S	
	B. Medium coarse to medium texture (sandy loam to loam) over compact till, or sometimes clay or silt, within 20-24".		7	Paxton, Woodbridge, Essex	S'	S'	S'	S	S	S	S	S	S	L*	S	S	L*	S	S	
	C. Finer textures (silt loam to clay).		8	Vergennes, Buxton	S'	S'	S'	S	S	S	S	S	S	L*	S	S	S	S	L*	
III. Somewhat poorly (imperfectly) and poorly drained (generally mottled with dark brown to gray A horizon).	A. Medium coarse to medium texture (sandy loam to loam).		9	Acton, Leicester, Ridgebury	L*	S'	S'	N	S	S	L	S	S	L*	Ln	S	L*	N	S	
	B. Finer textures (silt loam to clay).		10	Scantic, Panton.	N	S'	Ln	N	S	S	L*	S	S	L*	Ln	S	L*	N	L*	
IV. Very poorly drained ("Saturated" or "Ponded")	A. Mineral soils (dark surface over light gray subsoil, with or without mottling).		11	Whitman, Peru	N	N	N	N	L*	L*	N	N	S	L*	N	N	N	N	L*	Growth better when trees planted on raised hummocks found on unplowed soils. Often difficult sites better left unplanted.
	B. Mucks and peats.		12		N	N	N	N	N		N	N	N	L*	N	N	N	N	L*	

Legend

S - Suitable
- S Suitable; sites I to III.
- S' Suitable, but often better to plant more valuable species.

L - Limited
- L* Suitable on the more favorable conditions to texture, aspect or drainage within the unit. Also, in reference to Christmas trees, suitable with added culture or fertilization. Remainder of unit L⁻ or N.
- L⁻ Suitable but slow growth likely; sites IV to V.
- Ln Suitable as a nurse or for cover only. Long term survival or yield uncertain.

N - Not suitable (Usually hazards high and growth poor.)

[1]Texture refers to composite texture of A, B, and C horizons.

[2]Wherever erosion has been moderately severe to severe, use the recommendation given for one grade lower; i.e., drier, S & W slopes, and/or coarser texture sites.

Notes on species

JP - Northern portion of the area only.
RP - Not in southern New England except at higher elevations.
EL - More drought tolerant than JL.
WS - In southern section, more suitable as Christmas trees.
White cedar, Thuya - Except on # 12, hold to soils with surface pH above 6 or lime in upper subsoil.
BL - Avoid poorly drained or very acid soils. Subject to serious borer injury but useful as nurse.
Other hardwoods - Satisfactory development usually requires site preparation on thin sod, fertile soil, and lack of serious frost and animal damage.
Hemlock - Difficult to plant in open and in sod. Use for underplanting or hold to cool moist sites.
Balsam - Sod competition often severe. Hold to cool moist sites.

AREA C

Guide to Planting Site Classification and Species Adaptation

SITE CRITERIA					SPECIES																								NOTES ON SITES
																									Christmas trees				
Moisture relations	Texture and depth features	Other significant features	Site unit no.	Representative soil types	Jack pine	Pitch pine	Scotch pine	Red pine	White pine	Austrian pine	Norway spruce	White spruce	White cedar	Red cedar	European larch	Japanese larch	Black locust	Hybrid poplar	Black walnut	White ash	Sugar maple	Red oak	Tulip poplar	Black cherry	Scotch pine	Austrian pine	Douglas fir	Balsam fir	White spruce	
I. Excessively Drained. Shallow or coarse soils of low moisture holding capacity. "Dry sites"	A. Average depth to rock 20" or less over most of area, and deep pockets few.	a. High lime surface soils (>pH 7) over calcareous rock (place deeper or more favorable variants with # 6.)	1	Farmington, shallow phase Nellis, Benson, Wassaic.	N	N	Ln	N		L⁻	N	N	L⁻	L⁻	L⁻	N	Ln	N	N	N	N	Ln	N	N	N	L*	N	N	L*	These sites upgraded by N or E exposures, seepage, extensive bedrock fracturing (especially #1), and occurrence of deep soil pockets. On such sites L⁻ and L* approach S.
		b. Weakly to strongly acid soils over solid or weakly fissured rock. Rooting space less than No. 3.	2	Shallow Lordstown, Nassau, Shapleigh, Chatfield.	Ln	Ln	Ln	Ln			N	N	N		Ln	N	Ln	N	N	N	N	N	N	N	L*	L*		N	N	
		c. Weakly to strongly acid soils over fractured or uptilted rock penetrated by roots-shales, sandstones, schists and slates. Approaches #8 as root zone deepens.	3	Lordstown and Hollis.	L⁻	L⁻	L⁻	L⁻	L⁻			N	N	N	L⁻	N	Ln	N	N	N	N	N	N	N	L*	L*		N	N	
	B. Sands, loamy sands and gravels. (If underlain by silts or clays, place with II a.)	a. Coarse acid sands and loamy sands, usually medium to strong podsols.	4	Adams, Wallace, Colton, Colosse.	S	S	S	L*	L*		N	N			L*	L*	Ln	N	N	N	N	N	N	N	L*	L*		N		Infertility and frost are chief hazards. Otherwise L* = S. Fertilization may increase growth and choice of Christmas tree species.
		b. Acid loamy sands, gravelly sands and fine sands, weak podsols at most.	5	Colonie, Windsor, Otisville.	S'	S'	S	S	S		L*	L*			S	S	Ln	N	N	N	N	N	N	N	S	S	L*	L*	L*	
		c. Calcareous gravels and gravelly sands.	6	Kars, Bonaparte.			L*	N	L*	S	L*	L*	S	S	S	S	S	L*				L*			L*	S			L*	Surface soil reaction above pH 7 restricts susceptible conifers.
II. Well and Moderately Drained. Chiefly loam to silt loam soils, moderately deep to deep, without appreciable mottling above 20". "Slightly dry" to "fresh" sites.	A. Coarse textures, or very gravelly medium textured soils not under I. Mostly coarse sandy loams, very gravelly loams and shallow loams over sands and gravels.	a. Subsoil calcareous above 20-26". Surface usually above pH 5.5.	7	Kars, Grenville, Palmyra, Phelps.	S'	S'	S'	L*	S	S'	S	S	S	S	S	S	S	S		L*	L*	S		L*	S	S	S		S	
		b. Acid (<pH 5.8) throughout soil (May be calcareous at 5-15').	8	Alton, Trout River, Hoosic, Braceville.	S	S	S	S	S		L*	L*			S	S	Ln	N	N	N		L*			S	S	S	L*	L*	Infertility may limit growth.
	B. Medium textured soils, chiefly loams to heavy silt loams.	a. Acid throughout; upper soil usually below pH 5.6, C horizon usually below pH 6.0. Chiefly sandy loams to silt loams. Compare with #10.	9	Cossayuna, Worth, Dutchess, Troy, Sodus, Squires, Empyville.	S'	S'	S'	S	S		S	S		S'	S	S	S	L*	N	L*	L*	L*	N		S	S	S	L*	S	
		b. Similar to #9 but dryer or less fertile because: (a) severe erosion, (b) coarse sandy loam texture over fragipan or rock, or (c) S or W aspects above 25% slope.	10	Above, plus Rockway.	S	S	S	S	S		L*	L*			S	S	Ln	N	N	N	N	N	N	N	L*	L*		N	N	
		c. Medium acid soils, usually fine sandy loams to heavy silt loams, with acid surface but neutral or calcareous subsoil (pH above 6.5 at 36-40") reached by roots. (Place heavily eroded or less favorable sites with #9.)	11	Howard, Lansing, Ontario, Poland, Washington.	Ln	S'	S'	S	S	S'	S	S	S'	S'	S	S	S		L*	S	S	S	L*	S	S	S	S	L*	S	Productive agricultural soils only occasionally reforested except on broken topography.
		d. High lime soils, usually loams to heavy loams with surface near pH 6 and underlying soil neutral or calcareous.	12	Honeoye, Ontario, Madrid.			S'	L*	S	S	S	S	S'	S'	S	S	S	S	L*	S	S	S	S	S	S	S	S	L*	S	Surface reaction above pH 7.0 limits use of sensitive conifers.
	C. Fine textured soils; silty clay loams or clay loams in both A and B horizon. Usually lacustrine or marine but occasionally very fine till. (If drainage questionable, place with III D.)	a. Often friable surface, "tough" but well structured, permeable B horizons, weakly acid to neutral.	13	Vergennes, Hudson, Schoharie, Lucas.		S'	S'	L⁻	S	S	S	S	S'	S'	S	S	S	S	L*	S	S	S	S	S	S	S	S	S	Surface reaction above pH 7.0 limits use of sensitive conifers. These textures in reforestation lands often indicate #18.

Continued

SITE CRITERIA					SPECIES																					NOTES ON SITES
																						Christmas trees				
Moisture relations	Texture and depth features	Other significant features	Site unit no.	Representative soil types	Jack pine	Pitch pine	Scotch pine	Red pine	White pine	Austrian pine	Norway spruce	White spruce	White cedar	Red cedar	European larch	Japanese larch	Black locust	Hybrid poplar	Black walnut	White ash	Sugar maple	Red oak	Tulip poplar	Black cherry	Scotch pine	Austrian pine	Douglas fir	Balsam fir	White spruce	
III. Somewhat Poorly Imperfectly to Poorly Drained. Imperfectly drained soils sometimes not so recognized in dry weather, but usually mottled at 10-15" or above. "Fresh" or "moist" sites.	A. Mostly deep sands, on flat topography.	a. Usually strongly acid and podsolized.	14	Saugatuck.	N	L*	L*	N	L*		L*	L*	N	N	N	L⁻									L*	N		L*	L*	Infertility and frost are chief hazards. Uncultivated micro relief and surface organic matter upgrade site so L* = S.
	B. Lacustrine sands underlain by silts or clays, on flat topography.	a. Moderately acid to neutral; reaction usually above pH 5.5 at 12".	15	Swanton, Walpole.	N	L*	L*	N	L*		S	S	S		L*	L*									L*			L*	S	Uncultivated micro relief upgrades site. L* usually = S on Somewhat poorly drained soils or with micro relief.
	C. Mostly loams to heavy silt loams, often with fragipan.	a. Acid; surface reaction usually below pH 5.5. (Place coarser textured soils with #14.)	16	Albia, Pittstown, Westbury, Camroden.	Ln	L*	L*	N	L*		S	S	L⁻		L*	L*		Plant hardwoods only where subsoil friable to 24" or more, without marked gleying, and fertility and air drainage are favorable.							S			L*	S	
		b. High lime; surface reaction usually above pH 6, and C horizon neutral to calcareous.	17	Kendaia.	N	N		N	L*		L*	S	S		L*	L*									S			L*	S	
	D. "Clays" - Lacustrine and marine silty clay loams and clay loams. Usually friable surface and "tough" or plastic subsoils. Topography often level, but sometimes steeply incised slopes.	a. Usually weakly acid to neutral surface, neutral to calcareous below. Species ratings grade towards #13 as slope and drainage increases.	18	Panton, Madlin, Fulton, Odessa, Rhinebeck, Romulus.	N		N	N	L*		L*	L*	S		L⁻	L*									L*		N	L*	S	L* ratings generally = S on somewhat poorly unless surface alkaline; often = N on poorly drained.
IV. Very Poorly Drained. Very poorly drained soils with associated areas of poorly drained and swamps. "Wet sites"	A. Moist to wet alluvium along stream bottoms. Variable textures but friable.	a. Acid to calcareous; often fertile sites with heavy cover.	19	Wayland, Shoreham.	N	N	N	N	N		L*	L*	S		N	N	N	Very wet soils unsuitable. Others may be suitable if gleyed zone below 15".							L*	N	N	L*	L*	Competition, drainage and frost hazard restrict planting. Uncultivated micro relief upgrades site; L* and S species of #16 and 17 may be planted on hummocks.
	B. Poorly and very poorly drained soils of extensive flats, drainageways and swamp margins.	a. Variable texture, usually weakly and to alkaline.	20	Lyons, Tughill, Livingston, Toledo, Burnham.	N	N	N	N	N			L*	L*		N	N	N	N	N	N	N	N	N	N		N	N	L*	L*	
	C. "Swamps" - half bogs and peats.	a. Few such areas are plantable under ordinary treatment. Place drier or hummocky areas with #20.	21																										

Legend

S - Suitable
- S Suitable; sites I to III.
- S' Suitable, but often better to plant more valuable species.

L - Limited
- L* Suitable on the more favorable conditions to texture, aspect or drainage within the unit. Also, in reference to Christmas trees, suitable with added culture or fertilization. Remainder of unit L⁻ or N.
- L⁻ Suitable but slow growth likely; sites IV to V.
- Ln Suitable as a nurse or for cover only. Long term survival or yield uncertain.

N - Not suitable.

Notes on species

JP - A hardy species but of poor form and subject to windthrow on most soils. Use chiefly as nurse or cover on adverse sites.
PP - Suitable for deep dry sites and as nurse or cover on other adverse sites, especially in warmer parts of Area.
SP - Hardy, versatile species useful for cover on many sites. For sustained growth do not plant below somewhat poor drainage level. Use only suitable seed sources.
RP - Limit to good and high moderate drainage. Avoid soils above pH 6.5 in surface layer. European pine shoot moth limits use through much of Area.
AP - Capabilities not well known. Tolerant of lime and drought.
WP - A valuable and versatile species adapted to wide range of soils. Weevil prohibits use in much of area except with dense spacing or control.
NS - White pine weevil restricts use. Do not plant below imperfect drainage level or above pH 7 in surface soil. Use only suitable seed sources.
WS - Tolerant of poor drainage and lime. Plant with caution except at higher elevations; suitability to warm climates not known.
WC - Tolerant of drainage and alkalinity but seedlings sensitive to heavy sod competition. Needle miner injuries periodically.
RC - Tolerant of alkalinity and drought.
EL & JL - Restrict to good to somewhat poor drainage. European larch more tolerant of drought. Seedlings sensitive to heavy competition. Frost may prevent use in cooler parts of Area.
BL - Borer limits timber value except on best sites or with control. Restrict to well drained soils, loose or friable to 30" or more. Elsewhere as nitrogen-fixing nurse and cover.
HP - Capabilities not well known. Restrict to good to moderate drainage, or sites with moving water, and moderate to high fertility. Culture needed in establishment.
DF - Use proper seed sources. Restrict to sites with good air drainage, good to moderate soil drainage, and medium to high fertility.
BF - Limitations in Area not well known. Restrict to higher elevations and cool slopes. Tolerant of drainage, sensitive to sod competition in youth.
ALL HARDWOODS - In general, restrict to better soils, of good to somewhat poor drainage with high inherent fertility. Performance and form often poor without protection from frost, and animal damage. Culture often needed for establishment. Note climatic limitations of some species in cooler parts of Area.

AREA D

Guide to Planting Site Classification and Species Adaptation

SITE CRITERIA					SPECIES																								NOTES ON SITES
																			Christmas trees and cover							Untested species of promise		
Moisture relations	Texture and depth features	Other significant features	Site unit no.	Representative soil series	Pitch pine	Jack pine	Scotch pine	Red pine	White pine	Eruopean larch	Japanese larch	Norway spruce	White spruce	White cedar	Black locust	Sugar maple	Red & white oaks	White ash Black cherry	Black walnut	Scotch pine	Red pine	Austrian pine	Douglas fir	Balsam fir	Norway spruce	White spruce	Hemlock	Red cedar	
I. Excessively drained. "Dry sites" "Shallow sites"	A. Very shallow, medium textured soils. Average depth 15" or less to bedrock. (If underlain by shattered or fissured rock, treat as #3).	a. High lime soils over calcareous bedrock.	1	Farmington loam.				N		L⁻	N	N	N	L⁻	N	N	N	N	N		N	L⁻	N	N	N	N	N	L⁻	Plant pockets of deeper soil with drought and lime tolerant conifers and locust.
		b. Acid soils.	2	Very shallow phases of Lordstown, Oquaga loam.	L⁻	Ln	L⁻	L⁻		L⁻	N	N	N	N	N	N	N	N	N	L*	L*		N	N	N	N	N	L⁻	Usually noncommercial sites unless favored by aspect, seepage, etc. Plant pockets of deep soil with L* and L⁻ species. Drought hazards high.
	B. Shallow, medium textured acid soils, usually gravelly or stony. 20-30" over bedrock, or 15-25" to shattered rock. (Treat limy soils as favorable aspects of #1).	a. Warm slopes: SE to W aspect and over 15% slope.	3	Shallow Lordstown, Oquaga, Catskill, & Dekalb gravelly loams.	S		S	S	L⁻	S	L*	N	N	N	L*	N	L*	N	N	S	S	S	N	N	L*	N	N	S	L* refers to soil depth, aspect, and slope. Use L* species with care. Drought hazards high to moderate.
		b. Slopes less than 15% southerly. (Place cool northerly slopes >30% with #7.)	4	As above.	S	S	S	S	S	S	S	L*	N	N	L*	L*	L*	N	N	S	S	S	L*	N	L*	L*	N	S	L* refers chiefly to soil depth and aspect.
	C. Coarse sands & gravels. Mostly glacial deltas, terraces, creek bottoms.	a. Average slopes & fertility. (If water table within 3', treat as A.	5	Chenango, Arkport, & Podunk sandy loams.	S'	S'	S'	S	S	S	L*	N	N		N	N	N	N	N	S	S	S	N	N	N	N		N	Sandstone-siltstone-shale gravel usually allow good growth of deep-rooted species, although drought may affect establishment.
II. Well and Moderately Drained. "Slighty dry" to "Fresh" sites. No evidence of mottling or poor drainage above 15". Often on convex slopes.	A. Very gravelly or medium coarse textures. Usually sandy loams to very gravelly silt loams with open subsoils. (If subsoils not loamy below 30", treat as favorable phases of I-C). Mostly alluvial fans, Kames, terraces.	a. Surface slightly to medium acid, but pH 6.5 or above at 30."	6	Palmyra, Howard; Howard loam.	S'	S'	S'	S	S	S	S	S	S	S'	S	L*	S	L*		S	S	S	S		S	S	L*	S'	Limestone gravel in subsoil makes for inherent fertility. Suitability for spruce and hardwoods depends on loamy texture in subsoil.
		b. Acid throughout. Surface 4.5-5.5.	7	Chenango, Tunkhannock loam, gravelly loam.	S'	S'	S'	S	S	S	S	L*	L*	L⁻	L*	L*	S	N	N	S	S	S	L*		L*	L*	L*	S'	
	B. Medium textures; loams to silt loams, often stony (may be mottled at 18-22" & very firm at 22-26").	a. Average aspect & fertility. Treat warm aspects above 30% slope, or eroded areas as #7. (Treat favorable areas with friable subsoils as #9.)	8a	Well: Bath, Lackawanna, Woostern silt loam.	S'	S'	S'	S	S	S	S	S	S	L⁻	Ln	L	L*	L*	N	S	S	S	S	L*	S	S	S	S	These are the better drained upland soils to be distinguished from #12 and 13.
			8b	Mod.: Mardin, Culvers silt loam.				L*																					
	C. Medium fine to fine (heavy) textures; silt loams to silty clay loams.	a. Surface acid, usually <pH 5.8 but inherent fertility & base status> #8. Usually silt loam surface.	9	Lansing, Dunkirk silt loams.	S'	Ln	S'	L*	S	S	S	S	S	S'	L*	S	S	S	L*	S	L*	S	S	S	S	S	S	S	Check drainage conditions carefully on clayey tills or lacustrine deposits. *Strongly eroded* phases occasionally >pH 7.5 and unsuitable for most conifers.
		b. High lime and/or high fertility soils; ground cover usually dense. (If drainage doubtful, treat as #11.)	10	Honeoye silt loam, Schoharie clay loam.			Ln		L*	S	S	S	S	S	L*	S	S	S	S	S		S	L*	S	S	S	S	S	

Continued

SITE CRITERIA					SPECIES																					NOTES ON SITES
																		Christmas trees and cover							Untested species of promise		
Moisture relations	Texture and depth features	Other significant features	Site unit no.	Representative soil series	Pitch pine	Jack pine	Scotch pine	Red pine	White pine	European larch	Japanese larch	Norway spruce	White spruce	White cedar	Black locust	Sugar maple	Red & white oaks	White ash Black cherry	Black walnut	Scotch pine	Red pine	Austrian pine	Douglas fir	Balsam fir	Norway spruce	White spruce	Hemlock	Red cedar	
III. Somewhat Poorly Drained. "Moist sites" Wet in winter & spring. (Mostly silt loams on glacial till or gravelly alluvium and colluvium, often on 5-15% slopes.	A. 15" or more to very firm or compact layer.	a. High lime; pH 6 or above at 12". Often fine textured; ground cover heavy.	11	Kendaia, Ovid silty clay loams.		N	Ln	N	L*	S	S	S	S	S	N	L*	L*	L*	N	L*	N		L*	S	S		S	S	pH 7+ at surface eliminates conifers other than white spruce and cedar. Subsoil structure affects root penetration and growth.
		b. Average ground cover fertility & acidity (pH 4.5-5.5 at 12").	12	Red Hook, Volusia, Erie, Morris silt loams.	S'	Ln	S	N	S	S	S	S	S	N	N	L*	L*	N	N	S	L*	S	N	L*	S	S	S		Potential increases with depth of friable soil.
	B. Less than 15" to very firm or compact layer. Very wet in spring, dry in normal summers.	a. Uneroded, deeper than 30". Ground cover & fertility appear average.	13	Shallow surface phases of Volusia, Erie silt loam.	S	Ln	Ln	N	L*	L⁻	L⁻	L*	S	N	N	L	N	N	N	S	N		N	L*	S	S	S		Favorable early growth sometimes not maintained. Choose species with caution. 0-5% slopes may approach #14. Uncultivated micro-relief upgrades site.
		b. Strongly eroded or shallow to rock or compact & heavily mottled directly beneath plow layer.	14	Allis, Tuller, shallow variants of # 13.	L⁻		Ln	N	L⁻	Ln	Ln	L⁻	L⁻	N	N	N	N	N	N	L*	N	N	N	L*	L*	L*	S		Difficult sites; often noncommercial. Use hardy conifers; encourage mixtures of adapted local hardwoods and hemlock. Micro-relief upgrades site.
IV. Poorly Drained. "Wet sites" Poorly & very poorly drained soils, normally wet except in midsummer and fall.	A. Rooting depth variable according to water table and microrelief. Avoid wet-test sites.	a. High lime; surface pH 6.0 or above.	15	Lyons, Fonda, Romulus silty clay loam.	Ln	N	N	N	Ln	N	N	N	L*	L*	N	N	N	N	N		N	N	N	L*		L*		Unplowed soils often have somewhat better drained mounds. Otherwise difficult sites; usually noncommercial. Surface water and heavy competition often cause failures.
		b. Acid. Surface usually below pH 5.8.	16	Ellery, Chippewa, Norwich silt loam.	Ln	N	N	N	Ln	N	N	N			N	N	N	N	N		N	N	N	L*		L*		

Legend

S - Suitable
- S Suitable; sites I to III.
- S' Suitable, but often better to plant more valuable species.

L - Limited
- L* Suitable on the more favorable conditions to texture, aspect or drainage within the unit. Also, in reference to Christmas trees, suitable with added culture or fertilization. Remainder of unit L⁻ or N.
- L⁻ Suitable but slow growth likely; sites IV to V.
- Ln Suitable as a nurse or for cover only. Long term survival or yield uncertain.

N - Not suitable

Notes on species

PP - Hardy versatile species, especially for cover on dry or poorly drained sites.
JP - Form often coarse; may root shallowly. Use chiefly as cover.
SP - Use seed sources suitable for timber. Hardy, versatile but use with caution on imperfect to poor drainage.
RP - Only on excessive and well drained soils and where free of European pine shoot moth.
WP - Very versatile species. Use only where protected against weevil damage. Growth fair, but subject to disease, at imperfect drainage.
EL & JL - Fast growing, not fully tested. Use with caution on #13. European larch appears more drought resistant.
NS - Use suitable seed sources and protect against W.P. weevil. Use with caution on 13-16.
WS - Promising, not adequately tested. Tolerant of alkalinity and drainage.
WC - Tolerant of alkalinity and drainage; slow growing. Needle miner and weed competition restrict use.
BL - Use only on well drained friable subsoils; otherwise only Ln. Locust borer limits value.
SM - Use only on favorable sites, preferably with culture or nurse crop.
RO - Use only on favorable sites, preferably with culture or nurse crop.
WA & BC - Use only on most favorable sites with culture and protection against frost and animals.
BW - Only on fertile high lime sites with adequate moisture and culture..

Christmas trees
- SP - Use seed sources suitable for Christmas trees. Plant with caution.
- RP - Use caution on moist sites.
- AP - Tolerant of dryness and alkalinity. Tolerance of poor drainage not well known.
- DF - Frost sensitive. L* indicates restriction to sites with good air drainage.
- BF - Tolerant of drainage and high pH (<7). Seedlings very susceptible to drought and sod competition.
- NS - Protect against weevil. May have limited use on wet soils.
- WS - Appears to tolerate poor drainage, at least in youth, but may yellow.
- H - Susceptible to drought and sod competition; difficult to plant; tolerant of soil, drainage and shade.
- RC - Tolerant of alkalinity and drought.

AREAS F and G

Guide to Planting Site Classification and Species Adaptation

SITE CRITERIA						SPECIES																			
																				Christmas trees					
I Drainage class[1]	II Depth[2]	III Composition[3]	IV Texture[4]	V Local climate[5]	Site unit no.	White pine	Red pine[7]	Jack pine	Scotch pine	Pitch pine	Virginia pine	Shortleaf pine[7]	European larch	Japanese larch	Norway spruce	Yellow poplar	Red oak	White ash	Black locust	Black walnut	Douglas fir	Blue spruce	Norway spruce	White spruce	White pine	Scotch pine	Austrian pine
I. Excessive and Somewhat Excessive	A. Very shallow and shallow	--	Coarse to medium	Relatively Warm-Dry	1	N	N	S	S'	S	S	S	L*	N	N	N	L⁻	N	Ln	N	N	N	N	N	L*	L*	L*
				Cool-Moist	2	L⁻	L*	S	S'	S	S	S	S	N	N	N	L⁻	N	Ln	N	N	N	N	N	L*	S	S
II. Good and Moderately Good	A. Shallow	--	(All)	Warm-Dry	3	L*	L*	S	S'	S	S	S	S	L*	L*	N	L*	L*	Ln	N	L*	L*	S	S	S	S	S
				Cool-Moist	4	S	S	S	S'	S	S	S	S	L*	S	N	L*	L*	Ln	N	L*	L*	S	S	S	S	S
	B. Deep	Non-Calcareous	Medium	Warm-Dry	5	S	S	S'	S'	S'	S'	S	S	S	L*	L⁻	S	L*	Ln	N	L*	L*	S	S	S	S	S
				Cool-Moist	6	S	S	S'	S'	S'	S'	S	S	S	S	L⁻	S	L*	Ln	N	L*	L*	S	S	S	S	S
			Fine	(All)	7	L*	L*	S'	S'	S'	S'	S	S	S	S	S[6]	S	S[6]	S	S[6]	S	S	S	S	S	S	S
		Calcareous	Medium	(All)	8	S	N	L*	L*	S'	L*	L*	S	S	S	S	S	S	S	L*	S	S	S	S	S	S	S
			Fine		9	L*	N	L*	L*	S'	L*	L*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
III. Somewhat Poor and Poor	A. Shallow	--	(All)	(All)	10	S	N	N	N	S	N	N	L*	L*	L*	N	L*	S	N	N	N	N	L*	L*	L*	L*	N
	B. Deep	--	(All)	(All)	11	S	N	N	N	S	N	N	L*	L*	L*	L*	L*	S	N	N	N	N	L*	S	S	S	N
IV. Very Poor	A. (All)	--	(All)	(All)	12	L*	N	N	N	L⁻	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Legend

S - Suitable
- S Suitable; sites I to III.
- S' Suitable, but often better to plant more valuable species.

L - Limited
- L* Suitable on the more favorable conditions to texture, aspect or drainage within the unit. Also, in reference to Christmas trees, suitable with added culture or fertilization. Remainder of unit L⁻ or N.
- L⁻ Suitable but slow growth likely; sites IV to V.
- Ln Suitable as a nurse or for cover only. Long term survival or yield uncertain.

N - Not suitable

Notes on the Classification System

[1] Drainage Class is used as defined in USDA Agric. Handbook No.18, p. 170-172.

[2] Depth Class is used as defined in USDA Agric. Handbook No. 18, p. 297-298. Shallow soils are generally less than 20" deep over bedrock.

[3] Composition refers to the influence of calcareous materials on the soil. Calcareous soils are neutral or calcareous, usually within the upper 3 feet; they have developed on limestones, calcareous schists, shale or slate parent materials. Non-calcareous soils have developed on acid sandstones, quartzites, ironstones, shales or slates. Shallow soils calcareous at the surface are unsuitable for conifers other than Austrian pine.

[4] Coarse textures refer to sands and loamy sands; Medium to sandy loams, loams and silt loams; and Fine to silts, silty clay loams, clay loams and clays. Occasional instances of coarse textured soils will be found where only medium are indicated in the guide. The productivity of such areas will generally be in the low range of the assigned rating.

[5] Ridge tops, and south- and west-facing slopes have a Warm-Dry local climate, relative to the surroundings. Cool-Moist local climate occurs on level areas, cores, and north- and east-facing slopes.

[6] Where erosion has been moderately severe or severe (USDA Agric. Handbook No. 18, p. 260-269) the rating is reduced to L⁻ for the species indicated.

Notes on Sites and Species

N. B. These planting guides are intended only for natural or cultivated soils, not for anthracite spoil banks.

[7] Red pine is now planted only in Areas F and D in Pennsylvania because of climatic limitations and high shoot moth hazard elsewhere.
Shortleaf pine is restricted to Area G and lower elevations in the southern and southeastern parts of Area F.
Jack pine is well suited for planting on the poorer dry sandy soils.
Virginia pine is well suited for planting on the poorer dry shale soils.
Scotch pine is not recommended for timber production in Pennsylvania because of its low product value.
Norway spruce is preferred to White spruce because of its faster growth.
Japanese larch is preferred to European larch except on the drier sites. Elsewhere Japanese larch grows as well or better, with much less variation from tree to tree.
Black locust is used chiefly for gully control. For timber production it should be used only on the very best sites with northeasterly exposure, to minimize borer damage.
Red oak and black walnut are seeded with treated seed, rather than planted.

Vegetative cover will often have great influence in initial success of plantations. Hardwoods do not compete well with a heavy sod cover. Conifers will seldom survive on cut-over hardwood land without control of hardwood sprouts.

AREA H

Guide to Planting Site Classification and Species Adaptation

SITE CRITERIA				SPECIES												
													Christmas trees[1]			
Moisture relations	Primary profile features	Secondary physical or chemical features	Soil series or types	White pine	Pitch pine	Shortleaf pine	Loblolly pine	Virginia pine	Japanese larch	Bald cypress	Yellow poplar	Red gum	Scotch pine	Austrian pine	Norway spruce	Douglas fir
I. Dry Sites. Soils deep and excessively drained.	A. Deep (over 5 ft.) coarse to fine soils.	1. Sand with thick (8" or more) leached layer.	(1) Lakewood sand & fine sand	N	S	N	N	N	N	N	N	N	N	L[2]	N	N
		2. Sand with thin (8" or less) leached layer.	(2) Evesboro sand & loamy sand	N	S	S	L	L	N	N	N	N	N	L[2]	N	N
			(3) Gibbston sand & loamy sand													
			(4) Galestown sand & loamy sand													
		3. Sandy without conspicuous, leached layer.	(5) Choptank sand & loamy sand	N	S	S	S	S	N	N	N	N	N	N	N	N
		4. Coarse gravelly sand.	(6) Lakewood gravelly sand	N	S	N	N	N	N	N	N	N	N	N	N	N
	B. Beach sands	1. Sand bars offshore or connected to coast.	(7) Island Beach, etc. Bars of Chesapeake Peninsula	N	L	N	N	N	N	N	N	N	N	N	N	N
		2. Dunes of the coastal fringes	(8) N.J., Del., Md., dune sections	N	L	N	N	N	N	N	N	N	N	N	N	N
II. Well drained to slightly moist sites. Well and moderately well drained soils. No mottling above 24 inches.	A. Gravelly & sandy surface soils, somewhat more clayey subsoils, more or less hardened (or indurated) substratum ("C" or "D" horizon).	. . . . .	(9) Aura	N	S	L	N[nj]	L*	N[dm]	N	N	N	N	N	N	N
			(10) Chilum[dm] Croom[dm]	N	N	N	S[dm]	L*	N	N	L*	N	N	N	N	N
	B. Sand & loamy sand with fairly high water table.	. . . . .	(11) Galestown, Evesboro with fairly high water table	S	S	L	N	L*	L	N	N	N	N	N	N	N
	C. Loamy sands with more clayey subsoils, open substratum	. . . . .	(12) Freehold & Collington loamy sands	L	S	S	N	L*	L	N	N	N	L*	L	L*	L
			(13) Sassafras loamy sand	N	S'	S'	S	S'	N	N	L*	N	N	N	N	N
	D. Deep (4-5 ft.) loamy sands over clay	. . . . .	(14) Norfolk, Muirkirk, & Matawan loamy sands[dm]	N	S'	S'	S	S'	N	N	L*	N	N	N	N	N
	E. Sandy loams with more clayey subsoils, open substratum.	. . . . .	(15) Collington & Freehold sandy loams	L	S	S	N	L*	L	N	L	N	L	L	L	L
			(16) Sassafras & Greenwich sandy loams	N	L	S'	S	L*	N	N	L*	N	N	N	N	N
	F. Loams & Silt loams with more clayey subsoils, open substratum.	. . . . .	(17) Butlertown & Sassafras loams and silt loams	N	N	N	S	L*	N	N	L*	N	N	N	N	N
			(18) Collington & Freehold & Golts loams & silt loams	N	S	S	N	L*	L	N	L*	N	S	S	S	L
			(19) Matapeake & Colts Neck loams and silt loams	N	N	L	S	L*	N	N	L*	N	N	N	N	N
	G. Soils with clayey subsoils, generally plastic clayey substratum	. . . . .	(20) Christiana[dm]	N	N	L	S	L*	N	N	L*	N	N	N	N	N
			(21) Cliffwood, Monmouth, Matawan	N	L	L	N	L*	L	N	L*	S	S	S	S	L

Continued

SITE CRITERIA				SPECIES												
													Christmas trees[1]			
Moisture relations	Primary profile features	Secondary physical or chemical features	Soil series or types	White pine	Pitch pine	Shortleaf pine	Loblolly pine	Virginia pine	Japanese larch	Bald cypress	Yellow poplar	Red gum	Scotch pine	Austrian pine	Norway spruce	Douglas fir
III. Moderately wet sites. Somewhat poorly to poorly drained soils.	A. Somewhat poorly drained; top soil well drained, subsoil poorly drained. Top soil various hues of brown.	1. Open medium soils, subsoils heavier than surface soils--moving water														
		a. Withour greensand	(22) Woodstown, Holmdel, Adelphia	L	S	L	N	L*	S	N	S	S	L	L	L	L
		b. With greensand	(23) Mahapex[dm]	N	N	N	S	S'	N	N	S	S	N	N	N	N
		2. Open light soils, profile sandy throughout; moving water	(24) Klej	L	S	S	N	L*	S	N	L	S	L	L	L	L
		3. Tight heavy soils, profile clayey throughout; still water														
		a. Without greensand	(25) Keyport	L	L	S	N	L	S	N	L	S	L	L	L	L
		b. With greensand	(26) Donlonton & Berwyn[dm]	N	N	N	S	S'	N	N	N	N	N	N	N	N
		4. Soils with hardpan in subsoils	(27) Beltsville[dm]	N	N	N	S	S'	N	N	L	L	N	N	N	N
	B. Poorly drained; both top and subsoil poorly drained. Top soil dark gray.	1. Open medium soils, subsoils heavier than surface soils, moving water														
		a. Without greensand	(28) Dragston[dm]	N	N	N	S	N	N	S	N	N	N	N	N	N
			(29) Fallsington	L	S	S	N	L	S	N	L	S	N	N	N	N
		b. With greensand	(30) Shrewsbury	L	S	L	N	L	S	N	S	S	N	N	N	N
			(31) Othello[dm]	N	N	N	S	N	N	S	N	N	N	N	N	N
		2. Open light soils, profile sandy throughout; moving water	(32) Leon, Plummer	N	S	L	N	L*	S	N	N	L	N	N	N	N
		3. Tight heavy soils, profile clayey throughout; still water														
		a. Without greensand	(33) Elkton	N	L	L	N	N	S	N	S	S	N	N	N	N
		b. With greensand	(34) Colemantown	N	L	S	N	N	S	N	S	S	N	N	N	N
		4. Soils with hardpan in subsoils	(35) Leonardtown[dm]	N	N	N	S	N	N	N	N	N	N	N	N	N
IV. Wet sites. Very poorly drained mineral soils with 2-12" of organic matter.	A. Water remains in profile perennially.	1. Open soils, subsoils heavier than surface soils	(36) Pocomoke, Keansburg	N	S	N	N	L⁻	N	N	N	S	No Christmas trees of any species are recommended for "IV".			
			(37) Johnston[dm], Portsmouth[dm]	N	N	N	S	N	N	S	N	N				
		2. Open soils, very sandy throughout	(38) Rutledge, St. Johns	N	S	N	N	N	N	N	N	S				
		3. Tight soils, profile clayey throughout	(39) Bayboro (Alloway), Matlock	N	L	N	N	N	N	N	N	S				
			(40) Bladen[dm]	N	N	N	S	N	N	S	N	N				
V. Bogs. Permanently wet.	A. Inland bogs.		(41) Peats, muck	No recommendations of any species on "V" at present time.												
	, Coastal bogs affected by salt spray		(42) Peats, muck													

Legend

S - Suitable
- S Suitable; sites I to III.
- S Suitable, but often better to plant more valuable species.

L - Limited
- L* Suitable on the more favorable conditions of texture, moisture or drainage within the unit.
- L⁻ Suitable, but slow growth likely; sites IV to V.

N - Not Suitable

Notes on species

[1]There are no recommended species for Christmas tree planting on the coastal plain of Del & Md. Many species of spruce and fir are being field-tested in N.J. for hardiness.

[2]Field planting tests of hybrid Austrian pines and other exotic hard pines are now being conducted to determine suitability on dry sites. These trees may also be used for timber if hardy.

[dm]Delaware and Maryland only.

S[dm] Loblolly pine is considered the most valuable pine in Del. & Md. and is recommended for planting where both shortleaf and Virginia pine now grow (in Del. and Md. portions of area "H").

N[nj] Loblolly pine is not recommended for any sites in N.J. because of sweet fern rust.

WP - White pine is subject to moderate to severe weeviling throughout area "H".

JL - Japanese larch is not recommended for any sites in Del. or Md.

SP - Scotch pine on all sites is subject to shoot tip moth damage. Must be sprayed.

NS - Norway spruce on many sites is subject to weeviling. Must be sprayed.

YP - Yellow poplar suitable only on moister soil phases that are due to a local condition.